

What is claimed is:

1. Apparatus for modeling and evaluating the characteristics of three-dimensional forms which comprises, in combination,

a deformable translucent material that may be manually shaped to define a surface,

means for transmitting electromagnetic energy through said material to produce radiation from individual regions of said surface, said radiation from each given one of said regions having an intensity that is related to the position of said given region,

means for measuring the intensity of said radiation to produce surface geometry data indicative of the shape and position of said surface, means for processing said surface geometry data to generate result data which specifies one or more characteristics of said surface at different points on or near said surface, and

means for projecting an image corresponding to said result data onto said surface.

2. Apparatus for modeling and evaluating the characteristics of three-dimensional forms as set forth in claim 1 wherein said deformable material comprises a bed of translucent beads.

3. Apparatus for modeling and evaluating the characteristics of three-dimensional forms as set forth in claim 1 wherein said deformable material is supported on a rotatable turntable.

4. Apparatus for modeling and evaluating the characteristics of three-dimensional forms as set forth in claim 1 wherein said deformable material is a translucent material that can be shaped and once shaped retains its shape.

5. Apparatus for modeling and evaluating the characteristics of three-dimensional forms as set forth in claim 1 wherein said means for measuring is a three-dimensional optical distance measuring device.

6. Apparatus for modeling and evaluating the characteristics of three-dimensional forms as set forth in claim 1 wherein said means for measuring is a camera for capturing a radiation image produced by said radiation from individual regions of said surface.

7. Apparatus for modeling and evaluating the characteristics of three-dimensional forms as set forth in claim 6 wherein electromagnetic energy is infrared light energy.

8. Apparatus for modeling and evaluating the characteristics of three-dimensional forms as set forth in claim 6 wherein said means for projecting an image corresponding to said result data is located near said camera.

9. Apparatus for modeling and evaluating the characteristics of three-dimensional forms as set forth in claim 8 wherein said deformable material is a bed of translucent beads that is illuminated from beneath by a source of said electromagnetic energy and wherein said camera and said means for projecting an image are both located above said bed of translucent beads.

10. Apparatus for modeling and evaluating the characteristics of three-dimensional forms as set forth in claim 6 wherein said camera produces digital image data.

11. Apparatus for modeling and evaluating the characteristics of three-dimensional forms as set forth in claim 10 wherein said means for measuring the intensity of said radiation further comprises means for converting said digital image data into said surface geometry data.

12. Apparatus for modeling and evaluating the characteristics of three-dimensional forms as set forth in claim 11 wherein said means for converting said digital image data into said surface geometry data further comprises means for compensating for the nonlinear relationship between the intensity of the radiation for each given one of said regions and the position of said given region.

13. Apparatus for modeling and evaluating the characteristics of three-dimensional forms as set forth in claim 10 wherein camera produces a sequence of radiation image data captured at different exposure times and wherein said means for measuring the intensity of said radiation further comprises means for combining said sequence of radiation image data to produce said surface geometry data.

14. Apparatus for modeling and evaluating the characteristics of three-dimensional forms as set forth in claim 13 further comprises means for compensating for the nonlinear relationship between the intensity of the radiation for each given one of said regions and the position of said given region.

15. Apparatus for modeling and evaluating the characteristics of three-dimensional forms as set forth in claim 1 wherein said means for processing said surface data comprises means for translating said surface geometry data into a standard geometry format and means for selecting and executing an analysis routine from a library of available analysis routines for processing said data in said first standard form to generate said result data.

16. Apparatus for modeling and evaluating the characteristics of three-dimensional forms as set forth in claim 15 wherein said means for processing further comprises means for representing said result data in a standard graphical display format and for thereafter processing said result data in said standard graphical display format into image data supplied to said means for projecting an image corresponding to said result data onto said surface.

17. Apparatus for modeling and evaluating the characteristics of three-dimensional forms as set forth in claim 15 wherein means for processing includes means for generating different sets of result data using corresponding ones of said available analysis routines, and wherein said means for projecting projects a plurality of images concurrently, each of which corresponds to one of said sets of result data, whereby a user can simultaneously view different characteristics of said said surface.

18. Apparatus for modeling and evaluating the characteristics of three-dimensional forms as set forth in claim 1 wherein said means for processing further comprises means for representing said result data in a standard graphical display format and for thereafter processing said result data in said standard graphical display format into image data supplied to said means for projecting an image corresponding to said result data onto said surface.

19. Apparatus for modeling and evaluating the characteristics of three-dimensional forms as set forth in claim 1 wherein said surface geometry data comprises an array of values each of which specifies the elevation of said surface at a particular location in two-dimensional array of locations.

20. Apparatus for modeling and evaluating the characteristics of three-dimensional forms as set forth in claim 19 wherein said surface geometry data conforms to the Digital Elevation Model for representing topographical data.

21. Apparatus for modeling and evaluating the characteristics of three-dimensional forms as set forth in claim 20 wherein said means for processing said surface geometry data comprises means for selecting and executing a routine in a library of routines for processing said data into result data.

22. Apparatus for modeling and evaluating the characteristics of three-dimensional forms as set forth in claim 21 wherein said surface is a topological landscape surface and wherein said library includes for generating result data which specifies characteristics of said surface selected from a group consisting of: slope, curvature, shadowing, solar radiation, field of view, cost of passage, water flow and land erosion characteristics.

23. Apparatus for modeling and evaluating the characteristics of three-dimensional forms as set forth in claim 1 further comprising means for storing said result data as a voxel dataset representing the characteristics of said surface and a three dimensional region surrounding said surface, means for measuring the position of a second surface, and means for projecting an image corresponding to a selected portion of said voxel dataset defined by the position of said second surface relative to said first surface.

24. The method for modeling and evaluating the characteristics of three-dimensional forms which comprises, in combination, the steps of:
manually shaping a deformable translucent material to define a surface model,
transmitting electromagnetic energy through said material to produce radiation from individual regions of said surface model, said radiation from each given one of said regions having an intensity that is related to the position of said given region,
measuring the intensity of said radiation to produce shape data indicative of the shape and position of said surface model,
processing said shape data to generate result data which specifies one or more characteristics of said surface model at different points on or near said surface, and
projecting an image corresponding to said result data onto said surface model.

25. The method for modeling and evaluating the characteristics of three-dimensional forms as set forth in claim 24 wherein said deformable translucent material is a bed of translucent beads.

26. The method for modeling and evaluating the characteristics of three-dimensional forms as set forth in claim 25 wherein said step of transmitting said electromagnetic energy comprises transmitting infrared light through said material from an array of light emitting diodes positioned beneath said bed of translucent beads.

27. The method for modeling and evaluating the characteristics of three-dimensional forms as set forth in claim 26 wherein said step of measuring the intensity of said radiation to produce shape data comprises using a digital camera to capture digital image data representing the intensity of said radiation.

28. The method for modeling and evaluating the characteristics of three-dimensional forms as set forth in claim 27 wherein said step of using said digital camera comprises capturing a sequence of radiation image data taken at differing exposure times and combining said sequence of radiation image data to produce composite image data having a greater dynamic range.